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Editorial

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New devices and software have made it possible for consumers worldwide to create, manipulate, share, and enjoy media more efficiently in digital forms. Internet and wireless networks permit the delivery and exchange of multimedia information for such purposes as remote collaboration, distant learning, and entertainment. A major concern of traditional content owners is the ease with which perfect digital copies can be created and distributed. These companies have argued strongly for rights management technologies to assure that content is delivered and used for its intended purpose and by its intended recipients.

The successful development and adoption of media security and rights management technologies involve issues within and beyond technology arena. The 1990s witnessed a surge in interest in media security technologies, as evidenced from the huge rise of literature on multimedia security and rights management. Much of the industrial interest was directed to the protection of movies and music. The DVD format, the first high-quality digital video format for consumers, was released in 1997 and the Copy Protection Technical Working Group (CPTWG) of the DVD Consortium was responsible for investigating a variety of protection technologies to allay Hollywood's concerns that such a format would lead to widespread piracy similar to that being witnessed by the music industry. Contemporaneously, the music industry created the secure digital music initiative (SDMI) to identify technologies to inhibit the copying of music.

The SDMI is largely regarded as a failure while the CPTWG's efforts are somewhat mixed. The latter deployed a variety of technologies including (i) a content-scrambling system (CSS), (ii) Macrovision's analog protection system (APS), and (iii) a secure key exchange mechanism to permit the transmission of digital content between compliant devices. A fourth technology, digital watermarking, was not adopted. The decision to deploy particular technologies was based on both technical merit and commercial and political expedience. The latter manifests itself in the conflict of interests between content owners, consumer electronics (CE), and computer manufacturers. The content owners are clearly the beneficiaries of antipiracy technology. However, in most deployment scenarios, the cost of these technologies is borne by the CE and computer industry, who do not directly benefit from such technologies and whose customers are not in favor of it. As a result, consumers prefer to purchase equipment from manufacturers who poorly implement security technologies and are therefore easy to circumvent. There is little commercial incentive, except the threat of legal actions, for manufacturers to develop secure devices, and Hollywood's beneficiaries have shown a strong reluctance to bear the cost of these technologies.

Hollywood's attitude may be changing. This year (2004) witnessed the widespread reporting of the fact that Hollywood had identified the source of pirated material to a video provided as a "screener" to one of the members of the Academy of Motion Picture Arts and Sciences. Screeners are copies of movies that are provided to the voters of the Oscars. In this case, each screener had a unique identifier embedded in it, using digital watermarking technology.

The ultimate success of digital rights management requires a delicate balance between technology, business, and the law. We note that several standardization consortia, notably the MPEG standard group, the Digital Media Project (DMP), and the Secure JPEG 2000 (JPSEC), are actively pushing forward standards to support the interoperability of media security and rights management systems.

The objective of this special issue is to bring together recent advances in research, development, and standardization of multimedia security and rights management to meet the technical challenge. It is not surprising to see that signal processing plays a key role in addressing the unique characteristics of multimedia signals in contrast to generic data. In the meantime, providing security and protection to multimedia often requires combining signal processing theory, cryptology, coding theory, communication theory, information theory, and psychophysiology theory in human visual/auditory perception. A signal processing focus coupled with the interdisciplinary flavor is reflected by the twelve papers collected in this special issue.

The first six papers address issues on robust data embedding, which provides an important building block for multimedia rights management. A major advantage of data embedding is its capability of associating some additional data with the digital multimedia content in such a seamless way that few conventional protection tools for generic digital data such as cryptographic encryption can achieve.

The paper "Facilitating watermark insertion by preprocessing media" by Cox and Miller focuses on a complexity-constrained scenario rising from real-world rights management applications. More specifically, the embedding of watermarks to multimedia content must be accomplished with very limited computational power, while there is a considerable amount of freedom to determine and adjust the multimedia signals feeding into the embedder. The paper proposes and analyzes preprocessing techniques to enhance the robustness of embedded watermarks.

Given that a proper choice of filter bank can significantly influence the perceptual quality and robustness of wavelet-domain watermarking, the paper "Filters ranking for DWT-domain robust digital watermarking" by Dietze and Jassim aims at studying the relationship between various embedding parameters/strategies and the performance ranking of different wavelet filters. The study suggests that the subbands chosen for embedding, the embedding method, and the types of compression attacks are the influential factors. Consequently, the optimal filters under several embedding and attack combinations are identified in the paper.

In "Linear and nonlinear oblivious data hiding," Gang et al. study the oblivious/blind watermarking techniques that can reliably extract hidden information without reference to the original unmarked signal. The paper first examines performance and identifies limitations of the linear techniques based on direct-sequence modulation. An improved nonlinear technique is then proposed based on set partitioning.

The paper "RST-resilient video watermarking using scene-based feature extraction" by Jung et al. proposes a set of DFT-based spatial-temporal features as watermarking domain and employs constrained optimization techniques to embed desired watermark in the chosen features. The experiments demonstrate that the proposed watermark can resist compression, spatial geometric distortions, and temporal attacks.

Recognizing that the bit rate changes after watermarking can trigger buffer overflow or underflow during the video streaming, the paper "Improved bit rate control for real-time MPEG watermarking" by Pranata et al. proposes a compressed-domain watermarking technique for MPEG video. The proposed technique explicitly performs rate control and can maintain a targeted bit rate for the watermarked video.

The paper "Watermarking algorithms for 3D NURBS graphic data" by J. J. Lee et al. addresses the protection for 3D graphic data represented in nonuniform rational B-splines. By working with a few virtual images based on parametric sampling of a 3D graphic model, the new 3D watermarking algorithm can take advantage of the existing techniques for images. The experimental results show that the new algorithm is robust to various attacks and reparameterization. The authors also propose a steganography algorithm based on a similar idea of marking 2D features and demonstrate advantages over the conventional approaches.

The next three papers build forensic capability upon multimedia data embedding, providing digital domain evidence for traitor tracing and authentication in multimedia content management.

"Group-oriented fingerprinting for multimedia forensics" by Wang et al. embeds unique fingerprint signals in multimedia content to trace individual copies and deter information leak out of an authorized group of users. To combat multiple-user collusion attacks, the authors propose a hierarchical group-oriented construction of fingerprints, which takes advantage of the prior knowledge of social, cultural, and geographic ties between attackers and provides improved resilience against collusion.

The paper "Image content authentication using pinned sine transform" by Ho et al. proposes the use of pinned sine transform to decompose an image into two mutually uncorrelated fields. As one of the fields, known as the pinned field, contains the texture information, the authors embed the authentication watermark into this field to signal texture alteration while permitting a controlled amount of nontexture content-preserving changes.

In "A secure and robust object-based video authentication system," He et al. design an object-based authentication system capable of detecting malicious object tampering and in the meantime tolerating a number of content-preserving operations. The paper employs a region-based shape descriptor as the feature to which error correction coding and cryptographic hashing are applied to generate a robust authentication hash. The hash is then embedded in a semi-fragile manner into objects in the video and used for secure authentication.

The final three papers bring a system perspective to multimedia security and rights management, focusing on the integration of multiple protection mechanisms and system architectures.

In "MPEG-4 IPMP extension for interoperable protection of multimedia content," Ji et al. present a recent MPEG standardization effort on multimedia intellectual property management and protection with a focus on the interoperability. The paper provides an overview of the architecture, the protection signaling, and the secure messaging framework of MPEG-4 IPMP extension, as well as sample usage scenarios.

The paper "Secure multimedia authoring with dishonest collaborators" by Sheppard et al. concerns the content protection in a collaborative authoring scenario, where multiple users contribute to the content creation. The authors analyze the weaknesses of standard proof-of-ownership watermarking approaches against dishonest insiders, and propose several possible system architectures employing watermarks and fingerprints to overcome the weaknesses.

In "Video waterscrambling: Towards a video protection scheme based on the disturbance of motion vectors," Bodo et al. design a content protection mechanism for video that combines the functionality of watermarking and selective encryption. The proposed waterscrambling technique encrypts the motion vectors in the compressed domain such that an unauthorized user only sees a quality degraded video, and in the meantime allows the embedding of an invisible watermark for post-decryption protection.

Overall, these twelve papers provide a wide spectrum of technologies from academic and industrial contributors on multimedia security and rights management. We thank the authors, the reviewers, the Editor-in-Chief, and the publisher for their tremendous effort made to this special issue. We hope you, the readers, will enjoy the reading and find the results in this issue beneficial in understanding and building security and rights management systems for multimedia.

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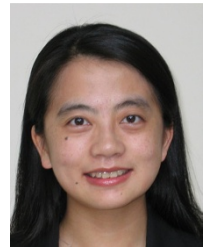
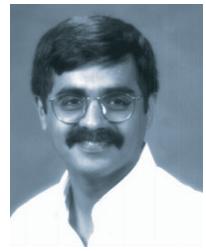


Min Wu received the B.E. degree in electrical engineering and the B.A. degree in economics from Tsinghua University, Beijing, China, in 1996 (both with the highest honors), and the M.A. degree and Ph.D. degree in electrical engineering from Princeton University in 1998 and 2001, respectively. She was with NEC Research Institute and Signafy Inc. in 1998, and with Panasonic Information and Networking Laboratories in 1999. Since 2001, she has been an Assistant Professor in the Department of Electrical and Computer Engineering, the Institute of Advanced Computer Studies, and the Institute of Systems Research at the University of Maryland, College Park. Dr. Wu's research interests include information security, multimedia signal processing, and multimedia communications. She received a CAREER Award from the US National Science Foundation in 2002, a George Corcoran Faculty Award from University of Maryland in 2003, and a TR100 Young Innovator Award from the MIT Technology Review Magazine in 2004. She coauthored a book, *Multimedia Data Hiding* (Springer-Verlag, 2003), and holds four US patents on multimedia security.



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Ingemar J. Cox received his B.S. degree from University College London and Ph.D. degree from Oxford University. He has worked for AT&T Bell Labs and NEC Research Institute and is currently Professor and Chair of Telecommunications in the Departments of Electronic Engineering and Computer Science at University College London. He has worked on problems to do with stereo and motion correspondence and multimedia issues of image database retrieval and watermarking. In 1999, he was awarded the IEEE Signal Processing Society Best Paper Award (image and multidimensional signal processing area) for a paper he coauthored on watermarking. From 1997 till 1999, he served as Chief Technical Officer of Signafy Inc., a subsidiary of NEC responsible for the commercialization of watermarking. Between 1996 and 1999, he led the design of NEC's watermarking proposal for DVD video disks. He is the coauthor of the book, *Digital Watermarking*, published by Morgan Kaufmann.